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(71) Applicant *(for all designated States except US):* THOMAS DE LA RUE & COMPANY LIMITED [GB/GB]; 6 Agar Street, London WC2N 4DE (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only) :* CHATWIN, Charles, Edward [GB/GB]; Slinfold House, The Street, Slinfold, Horsham, Surrey RH13 7RP (GB).

(74) Agent: GILL JENNINGS & EVERY; Broadgate House, 7 Eldon Street, London EC2M 7LH (GB).

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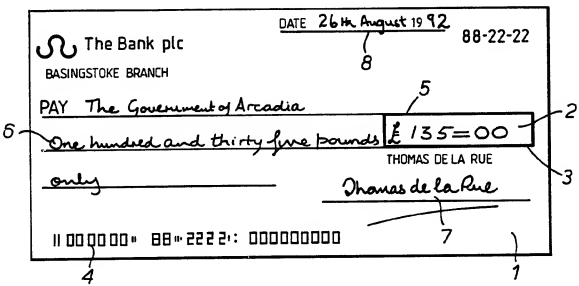

(57) Abstract

A method of inspecting a security document having an area which presents a characteristic appearance when illuminated under non-visible radiation and which, in use, carries one or more visible graphical characters. The method comprises illuminating the area under the non-visible radiation to derive data defining the appearance of the area; comparing the data with reference data; and indicating the result of the comparison.

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SECURITY DOCUMENT INSPECTION

This invention relates to the inspection of security documents, such as cheques.

When cheques are issued by a bank account holder, among the details handwritten (or mechanically or electronically printed) is the numerical financial value. This is placed within a predefined area which will be referred to as the amount box. The area of this box may be defined by a perimeter line, for example in the form of a rectangle. Fine lines may be drawn within the box to define a number of sub-areas in which individual numerical digits will be written.

The numerical written value will normally be supplemented with the same amount written in words elsewhere on the cheque.

Bank cheques also have areas within which the date of issue and the signature of the issuer are placed. Cheques also have the following preprinted information at the bottom of the cheque within an area which is reserved for automatic cheque clearance processing - bank identification code, account identification code, and the cheque serial number.

This invention is principally concerned with bank cheques, although it is also applicable to travellers cheques where verification of the signature is undertaken.

As part of a bank's present day cheque clearing operation a cheque is taken from a stack of cheques to be processed and fed on a conveyor and presented stationary in front of an operator who reads the handwritten numerical value. The operator then keys this value using a keyboard and that value of the cheque is then immediately printed in machine readable format, collinear with the other preprinted machine readable data, at the foot of the cheque. In a variant the image of the amount box could be optionally captured by a video camera and that image presented to the operator.

The process is then repeated from cheque to cheque. The machine readable formats may employ magnetic character

recognition or optical character recognition or both. The machine readable characters are however visually readable, usually being printed in black. A cheque will be rejected if the image seems wrong to the operator or if the machine reading equipment fails to read a character.

An enormous number of cheques is cleared by banks every day. The manual encoding method is highly labour intensive and relatively recently there have been moves to employ handwritten numerical image recognition means. Such means will allow automatic processing of cheques, reducing the number to be read by the clearance encoding operator to a minimum.

For this to work the recognition system analyses the image information in the amount box by converting the image into a bit mapped data format. If the mapped data corresponds to reference template data for the numbers the cheque is accepted. The recognised numerical value data may then be used automatically to print the value in machine readable format at the foot of the cheque.

No manual scanning is required for the majority of cheques. It is only those which are not recognised by the system which are passed for manual inspection and encoding.

Rather than printing the numerical value at the foot of the cheque the determined value data may be electronically forwarded to a database and combined with the data resulting from the OCR or MICR reading process. This data may then be passed to the bank from which the cheque is drawn: the cheque need not be physically transferred.

The character recognition scanners operate optoelectronically. Typically the amount box will be illuminated with visible light, perhaps a band of visible light such as white light. The sensors detect the difference in contrast between the numerical image and the background. A bit map of the numerical image in the amount box is formed.

Using this as a basis, the bit mapped image data is computer matched with data representing number shapes.

Computational correction may be made for the size, shape and orientation of the individual digits. If all scanned images are recognised as number shapes the apparatus prints the corresponding value in the machine readable code line (or sends it to a composite database.) Unless every digit is recognised the cheque is remitted to the operator.

During optical scanning of handwritten or similar numerical images the amount box is digitally mapped to form a pixel array. The perimeter markings may be used for scanner registration.

For the scanners to operate successfully i.e. to record a wide variety of sizes and density of numbers, the background within the amount box must have low optical density (so as not to be recorded as an image). Individual numbers must have higher optical density: they must have sufficient contrast. The photoelectric sensors may operate in binary mode: each pixel is attributed with image content or no image content.

In practice the density of the handwritten ink image (or any machine printed digits) will often be low and this means that the scanners will have to be sensitive. To allow improved contrast of faint handwriting the above mentioned density levels reduce the visible colour strength of the security printing background within the amount box significantly below that generally employed for the majority of cheques which are presently manually encoded. However by making this security pattern less visible it may be more difficult to verify visually whether forgery has occurred i.e. it may be more difficult to detect fraudulent alterations to the handwritten characters. It may also be more difficult to detect whether alteration of the security pattern has occurred: many cheques will not in future be visually inspected during clearance.

An example of a conventional cheque processing system is described in WO85/02148. This describes how certain information on a cheque can be automatically located and captured for subsequent reproduction on a statement. This is achieved by providing fluorescent areas which are detected and captured. Image and character recognition is handled separately in a conventional manner.

A method of processing handwritten documents by performing a histogram analysis of character pixel array for bank cheques is disclosed in EP344742A. This method is only used for speeding up cheque clearance.

GB 2216253B relates to testing cheques and bank notes by scanning bank notes with a CCD array and using sample signals to check validity. This appears aimed at locating counterfeits.

WO91/17521 discloses a hybrid feature based template matching optical character recognition system.

Conventional methods for automatically inspecting printed matter on bank cheques and the like are disclosed in EP-A-0083062, EP-A-0088169, EP-A-0078708, WO-A-8900319 and WO-A-8103507.

In accordance with one aspect of the present invention, a method of inspecting a security document having an area which presents a characteristic appearance when illuminated under non-visible radiation and which, in use, carries one or more visible graphical characters comprises illuminating the area under the non-visible radiation to derive data defining the appearance of the area; comparing the data with reference data; and indicating the result of the comparison.

In accordance with a second aspect of the present invention, apparatus for inspecting a security document having an area which presents a characteristic appearance when illuminated under non-visible radiation and which, in use, carries one or more visible graphical characters, comprises means for illuminating the area under the non-visible radiation; detection means for deriving data

defining the appearance of the area; and processing means for comparing the data with reference data, and for indicating the result of the comparison.

The invention provides a new method and apparatus for inspecting security documents which in one application is used to identify the graphical characters. For example, the characters may correspond to numerals written in non-luminescent form in an amount box which carries a luminescent coating on a cheque or the like and the comparison can involve carrying out a character recognition process of conventional form. The advantage of using luminescence over conventional optical character reading is that greater contrast is obtained between the non-luminescent graphical characters and the light emitting background which will typically be fluorescent or phosphorescent under the non-visible radiation.

A further, important application of the invention is in methods of verifying security documents particularly against fraudulent alteration and counterfeiting. For example, the method may further comprise a step of obtaining the reference data by illuminating the area at a different wavelength, typically within the optical range. In this way, a comparison can be made between the apparent normal visual appearance of the graphical characters and their appearance in relation to the characteristic appearance of the area under non-visible radiation. If there has been an alteration, for example a deletion, of part of the graphical character which is not visible under optical conditions, this will be apparent under non-visible radiation. For example, both the apparent graphical character shape and the deleted area will fail to luminesce. This allows a forged amount to be detected. On the other hand the absence of non-visible illumination induced luminenscence from the amount box would indicate that the cheque was a counterfeit, even if the amount value had not been forged.

In some applications, the data which is derived comprises a bit map of the area and the data which is compared may comprise a bit map of that portion of the area which does not exhibit the characteristic appearance when illuminated under non-visible radiation or the background to that portion.

In other applications, the data defines the meaning of the graphical characters, for example their numerical values. This data will have been obtained by implementing a conventional character recognition process.

The various applications of the invention will now be described in more detail.

1 DUAL SOURCE SCANNING

In a first example a bank cheque which has an amount box area exclusively reserved for handwriting or otherwise printing the value of the cheque in digits is automatically processed. The amount box area is photoelectrically scanned at a first (non-security) visible wavelength and a bit map prepared of the whole area of the amount box, image content being recorded in the bit map where the optical density is measured to be above a threshold.

The amount box is then automatically scanned at a normally invisible security attribute wavelength for example when luminescence is stimulated. A bit map of the image content at this wavelength is prepared. The bit maps obtained under the two sets of sensing conditions are then compared. If the two graphical maps coincide the item is verified. If there is a significant degree of mismatching the cheque is rejected for further inspection. The first image or the second image is used for numerical recognition processing. The other image may also be used for recognition processing and the determined numbers compared in addition or as an alternative to comparing the bit maps.

Numerical image recognition means can be employed to convert the or each bit map into a numerical data value.

This data value may then be used to drive a printer which automatically prints the recognised value in machine readable format at the foot of the cheque or it may be stored for combination with MICR/OCR data read from the cheque by appropriate means.

The security attribute may result from fluorescence of an invisible printing ink printed evenly over the amount box area so as to form a background. This visible fluorescence may be activated by ultraviolet light and the second scanning would be undertaken at a fluorescing wavelength. The markings would not fluoresce at that wavelength and the markings would mask any underlying fluorescence. Any attempt to erase the background would result in fluorescence being lost from an area and the area lacking fluorescence would be regarded as the second image.

It would be possible to compare the complete bit maps for the common amount box area, to compare the image content from first and second data sets for coincidence, to compare the two background data sets for coincidence, or to compare whether one image complements exactly the other data set's background.

Minor variances in the bit maps between the first and second images will often occur because of minor mismatching and registration variation. A matching confidence score may thus be computed. This can be used to determine whether the presented numerical value is to be regarded as authentic.

The illuminating light for the security attribute may be used to differentiate the luminescence of the masking from the background areas or the optical absorbances. The illuminating light source may be filtered to restrict the spectrum and the sensors may also be filtered.

As a refinement of this the first and second scanners may employ filtering means to differentiate by metamerism ink used for forgery. Additionally the scanners may record the first and second images at a

series of optical density levels to form a more elaborate data set.

The genuineness of the document may also be verified by the above means by the presence of an image on second scanning. It is also possible for the background to be formed with scanner resolvable microprinting and the particular pattern of fine line printing can be matched between the first and second scans or with comparison data.

In an alternative mode the amount box of the cheque may be scanned at only the security wavelength and the presence and graphical shape of the image obtained there used for both recognition and security verification. The security feature is thus detected in all areas other than where there is a recognisable numerical image. This method is more fully described below.

Cheques may be subjected to counterfeiting or forgery. In counterfeiting a copy of the whole document is offered as a genuine article. The counterfeiter may attempt to manufacture blank cheques or to manufacture a copy of an issued cheque. In forgery there is alteration of a genuine document: in cheques this will typically be the alteration of the value.

In order to defeat counterfeiting use can be made of the characteristic appearance of the cheque under the non-visible radiation which is not readily identifiable by a criminal but which can be detected by automatic sensing, other than the machine readable printing at the foot of the cheque. Preferably therefore the security attribute providing this characteristic appearance will be placed within the amount box. Alternatively, a separate security attribute is provided for this purpose. It should be invisible and not detectable by the primary image scanning means.

For example the amount box may be security printed with an invisible ultra-violet responsive luminescing agent such as a normally invisible, visibly fluorescing

dye. On illuminating the proffered cheque with ultra violet radiation the presence of fluorescence can be detected by the scanner and this used to indicate genuineness.

The presence of the security luminescence at a predetermined place on the document can be detected by a photoelectric sensor responsive to the fluorescing wavelength. If of sufficient optical density the detected authenticity signal allows the cheque to be passed for value printing. Otherwise automatic ejection means will cause it to be rejected, for example by being fed into a reject hopper.

In one example, the amount box may be provided with a luminescent coating which is used to read the graphical characters and with a complete or partial phosphorescent coating to provide additional security against counterfeiting.

The pixels forming the bit maps will generally be of identical size using a common point of registration such as the perimeter image of the amount box.

Both images may be manipulated by the processing means to provide the best match thus obviating the need for reference points. This however is likely to be relatively slow.

Examples of security markings which may be printed or applied to cheque paper and the like, preferably as substantially uninterrupted areas within the amount box and photoelectrically sensed are as follows: luminescing ink such as invisible ultraviolet responsive fluorescing dyes, ultraviolet responsive phosphors, near infrared responsive (anti-Stokes) fluorescers or phosphors, ultraviolet absorbing dyes, near infrared absorbing dyes, photochromic dyes, and inks containing magnetic or magnetisable particles including such inks which have a white of lightly coloured appearance.

When the above materials are used it is taken that the security paper and the ink or other medium in which the value is written do not have these background properties at the security sensing wavelength. If the security paper is inherently fluorescent under ultraviolet light, then an invisible, fluorescence quenching dye or obscuring printing could be used to create a contrasting security pattern. If this coating was removed, fluorescence would return and this would be detected on security scanning.

Security marking illuminants may include ultraviolet, near infrared or monochromatic or broad band visible light. Arrays of near-infrared light emitting diodes may be used.

Optical sensing may be undertaken with photodiodes, photoresistors, or CCD arrays if necessary screened by filters to allow the transmission of selective radiation, and usually removing the actinic radiation.

The optical sensing may be undertaken while the security illuminant is on as would be necessary for UV responsive dyes, or slightly later, as for phosphors. The delay between illumination and scanning for a phosphor adds another security variable.

Apart from counterfeiting, cheques are often subject to forgery. The paper or printing ink used for printing cheque blanks may have agents present which allow attempts at alteration to be spoiled. For example the cheques may contain solvent responsive agents such as fugitive inks, which cause permanent staining and which may be visibly detected. There may also be bleach reactive agents employed which on exposure to bleach give an irreversible stain which can be detected.

Such staining will generally cause a disruption of the number shapes expected to be found in the primary image or its background, or the secondary image or its

background. Apart from mismatch between the two samples, the primary or secondary image when subject to image recognition processing will normally also be found to be distorted. This would normally also be readily visibly detected.

The use of mechanical erasure may be employed by some forgers and this would be detectable on security illumination by providing an erasable coating which was ink receptive and contained a normally invisible ultraviolet responsive visible fluorescing dye. Erasable coatings are known for use on cheques such as in GB 2060491B. The anti-erasure coatings generally comprise a transparent film-forming polymer which incorporates a proportion of wax.

Ink receptivity which will be diminished by the presence of wax can be enhanced by the incorporation of silica powder which is highly ink absorptive. The invisible fluorescent dye would also be incorporated in the formulation.

An advantage of using luminescing coatings is that the contrast between the background and the image areas is enhanced. This for example allows the amount box to be security printed with a faint pattern of indicia, this box area then being overlain with a transparent erasable or other luminescing coating.

The invention can be extended for use with verification tags applied by cheque issuing companies. This tag will be affixed to very high value cheques at the instant of issue. This in effect would hinder the problem of stolen company or building society chequebooks being passed. Here it is the genuineness of issue that is being tested not counterfeit or alteration detection. It has been proposed that a machine (infrared) readable numbered tag be employed. The tags would be kept away from the cheques and a numbered tag would be issued only when a cheque above a minimum value was being prepared. During clearance the cheque's tag would be read by

a photoelectric device and the serial number matched for example to corresponding data obtained from machine reading the cheque as described above. This would supplement the value recognition analysis.

2 SECURITY ILLUMINANT SCANNING.

As an alternative to the above and one which avoids the need to scan at two substantially different illumination wavelengths, it is possible to provide verification and/or value recognition at one wavelength, the security (non-visible) wavelength. Thus for example the amount box may have faintly printed non-fluorescing background security indicia over the entire area, and this covered with an entire layer of an invisible, visibly fluorescing dye.

Image scanning would be undertaken on ultraviolet illumination, and recorded at a visible fluorescing wavelength and a bit map prepared of the fluorescence in the amount box. Image content would be indicated by the lack of fluorescence i.e. in the handwritten areas and altered areas. The bit map of the apparent image (corresponding to the inverse bit map of the background) would then be used for image recognition. If the apparent image matched the reference digit maps, then the cheque would be regarded as authentic.

The method may be enhanced by inspecting other variable indicia areas which have underlying fluorescent printings of the same kind to ensure that fluorescence is indeed present and for example there are no areas of apparent image content which are so large as to indicate fraudulent alteration.

In all these applications, the amount box area may optionally have associated with it coded markings which indicate the character of the information provided in the area so as to enable there to be discrimination between different styles of cheques which happen to have overlapping variable data areas of different character i.e.

only one of these areas is for the numerical value of the cheque, the other perhaps being for the date.

Optionally the amount box area may exhibit finely repeating printing such as of security line work, or miniature text or graphical images such as logos. The printed images may be formed by the absence of the luminescent coating in such areas or by the overprinting of the luminescent coating with a luminescence effect suppressing coating such as an opaque ink.

The image areas comprising the fine printing may also exhibit luminescence and optionally this may be designed to have the same luminescent intensity and coloration of the background coating such that the fine security printing which forms an all over pattern in the box is visible to the eye but is not distinguishable from the background by the luminescence sensing means.

Should there be a difference in appearance at the recording wavelength the data held on the computer to allow verification of the background pattern may be programmed to recognise the overall pattern of the amount box by use of bit mapping and matching methods.

The security markings forming the non-variable indicia in the amount box will generally be printed in faint colours and optionally with rainbowed inks using the methods known in the security printing industry. Such print density and the hue may be such that it will interfere with the reproduction methods used in photographic colour separation methods, electronic image scanners and electrostatic colour copiers including dot image colour copiers. The security indicia may be printed in coloured inks or using special purpose inks such as lustrous metallic inks which may be tinted or rendered luminescent, optically variable inks, photochromic inks, fugitive (i.e. solvent sensitive or bleach sensitive) inks and the like.

The above security patterning of the amount box may also be employed in other areas of the document which are

to receive variable information such as a date or signature.

The luminescent coating covering the amount box will comprise a luminescing agent such as a fluorescent or phosphorescent pigment or dye. Other additives such as tints, colourants, and X-ray opaque materials may be added in small proportion. Generally such fluorescent or phosphorescent compounds will be selected to respond to ultraviolet light and visibly luminesce but the use of visibly luminescing materials which respond to near infrared illumination may occur.

During inspection the image of the amount box containing the printed value may be recorded instantaneously by photographing the entire area with a CCD camera or the like. Alternatively the bit map for the amount box may be recorded pixel line by line i.e. in linear array manner, such lines generally being selected to be orthogonal to the direction of the cheque's transportation through the verification unit.

In this instance the two dimensional bit map array is compiled over a number of time intervals and then when complete the verification method may be employed on the recorded bit map array.

As a further refinement the variable indicia in the amount box may be subjected to automatic colorimetric, line thickness and/or ink density analysis within the computer using appropriate algorithms to determine whether a forged line has been provided, say, written by a different pen.

3 OTHER APPLICATIONS

The above description has mainly been confined to the use of the method for the verification and recognition of bank cheque values. There is however a more general applicability which will now be described.

Many security documents are personalised on their surface with personalising indicia printed by toner or by film transfer means. For example the MICR/OCR line on cheques will generally be printed by impact printing

in which an image wise portion of black film which may be magnetisable is transferred from a carrier film. Passport visas often carry laser (electrostatic) printed personalised details on their surface. Identity cards may also be personalised by laser printing using toner.

Criminals make attempts to alter such documents and it is important to ensure that such individualised documents are genuine.

The invention can provide a method of automatically verifying variably printed indicia on a security substrate, in which the area which is to bear the indicia supports a print receptive coating which is responsive to optical scanning. The area comprising the variable printing on the specimen document is then read either by dual wavelength scanning or security wavelength scanning alone.

The variable printing may be applied by conventional means such as by the use of a letterpress numbering box in the application of ink or transfer films to form serial numbers, or by electronically controlled means such as printing in toner or with impact transfer films. Because of the presence of the underlying security coating any changes which may not be readily recognisable to the eye will be detected on automatic scanning.

In the above the security marking composition will generally be printed evenly over a given area such as an amount box but in the alternative a fine line pattern such as a grid may be printed and this pattern also used for verification.

The personalising of documents whether cheques, passports, visas, identity cards involves the placing of markings of various types. The markings may be made by handwriting in ink, or placed by typing, mechanically transferring an alphanumeric shape, electrostatic toner transfer, impact printing, thermal dye transfer, ink jet printing and the like. Graphical symbols could also be printed as could facial images perhaps by

laser printing. The printing methods employed are often the same as are used commercially and it is desirable to be able to verify such personalised printing in order to make sure that the text printed at the time of issue has not been altered. For example a fraudulent attempt could be made to erase and rewrite a signature. The invention enables such fraudulent attempts to be detected.

Cheques generally contain reactive agents which will form a stain on contact with solvents, bleaches and the like. This stain may be noticed when the cheque is passed.

The invention provides additional means of verification, especially means which may be used on automatic processing lines, often where a series of documents are being processed.

The number of pixels in each data set should be sufficient to provide a reasonable degree of resolution in comparison with the size of the images likely to be offered. Excessive pixel grabbing may however increase the processing time unacceptably.

It is not necessary for every pixel to be compared. Every fourth pixel could be compared to save on processing time with an optional further higher resolution processing happening if the sample fell below a predetermined authenticity confidence level.

The image processing may be done to a series of documents which are being processed such as cheques. Alternatively individual documents such as identity cards may be inspected.

The image processing means described above are mainly intended for use with variable markings such as signatures, alphanumeric personalising information, handwritten cheque values, photographic facial images, fingerprint images and the like.

It is however possible to envisage the an extension of the method to verify features such as metameric

features. In this instance the first and second images would not be compared with each other but with reference samples held on a document reference attribute database.

Examples of a methods and apparatus for inspecting a security document in accordance with the present invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 shows a cheque for inspection;

Figure 2 illustrates the appearance of a part of the cheque illuminated at a first wavelength;

Figure 3 illustrates the appearance of a part of the cheque illuminated at a second wavelength;

Figure 4 shows the cheque of Figure 1 which has been printed with invisible fluorescent dye panels;

Figure 5 shows a part of the cheque before alteration;

Figure 6 shows a part of the cheque after alteration illuminated at a first wavelength;

Figure 7 shows the appearance of Figure 6 illuminated at a second wavelength; and,

Figures 8 and 9 illustrate schematically two types of apparatus for inspecting security documents.

Figure 1 shows a completed cheque 1 comprising an amount box area 2 defined by a printed perimeter line 3. The area 2 has been completely and evenly printed with a normally invisible, colourless, ultraviolet responsive visibly fluorescing ink which is mechanically erasable with an elastomeric eraser. The printed ink layer is receptive for the numerical amount, "135 = 00" handwritten in ink or otherwise printed in the amount box. The pound symbol 5 is preprinted.

The amount is also handwritten in ink in words in another location 6.

The cheque has been signed 7 and dated 8. Magnetic ink character recognition (MICR) symbols are printed on a machine readable area 4 at the foot of the cheque.

During clearance the cheque is passed through an amount value reading station 50(Figure 9) which prepares a

bit map of the amount box area 2 at a suitably fine resolution. The amount box 2 is illuminated with white light (Figure 2) and mapping is undertaken at a visible wavelength or wavelength band. The cheque 1 is carried by a conveyor 51 under a linear CCD array 52 which detects white light reflected from the cheque after supply from a source 53 via fibre optic cables 54. The output from the CCD array 52 is fed to a microprocessor 55 which analyses the output by comparison with a threshold to generate a bit map.

Bit mapped shapes 9-15, depicted in black in Figure 2 are then processed by numerical recognition software in the microprocessor 55 and each shape is recognised as being either numerical or a separation mark. The financial value of 135.00 is then assigned and stored as data in a memory 56.

The cheque 1 is then carried by the conveyor 51 to a second station 57 where the amount box 2 is illuminated by a source 58 via fibre optic cables 59 with ultraviolet radiation in comparative darkness, at a wavelength at which the invisible fluorescent dye fluoresces so emitting visible light in all areas of the amount box, other than that where the fluorescent ink is masked or missing (Figure 3). The fluorescence is detected by a linear CCD array 60 and fed to the microprocessor 55 which then generates a bit map of the amount box 16 under fluorescing conditions. As each pixel is scanned the presence or absence of fluorescence (according to a predetermined luminescence threshold) in the pixel determines whether the data value for that pixel is provided with an image attribute or a background attribute.

The characters recorded in the bit map are then identified and compared with the characters previously stored in the memory 56. If they are the same the cheque is validated and the amount printed on the cheque in a conventional manner. Otherwise the microprocessor outputs

a signal diverting the cheque 1 to a manual analysis position.

In an alternative process, the memory 56 stores the bit map generated by the station 50 and then using a common datum point/s such as the corner/s of the amount box the bit maps of the first image of the numbers (i.e. from Figure 2) and the apparent numerical images, the non-fluorescing areas of Figure 3, are then matched by the microprocessor 55. If complete overlap is established then the cheque is validated. The data value assigned through numerical value image processing may be caused to be printed on the bottom machine readable encoding line of the cheque. Alternatively, the digital value may be allowed to be stored in a valid transaction database along with the MICR character data previously recorded from the cheque. The cheque in the present example has been deemed to be altered. The value has been changed by a forger from one hundred and thirty-three pounds to one hundred and thirty-five pounds. This change to both the numerical value and the textual value is not noticeable on normal visual inspection (Figure 1). It is however detectable on ultraviolet illumination.

In this instance the respective bit maps do not correspond because of the lack of fluorescence from not only the added line area which forms the "5" shape shown at 17 but also the lack of fluorescence from the horizontal line area which formed the uppermost part of the former digit "3".

As an alternative the two background bit maps from Figures 2 and 3 could be matched or one background could be matched with the other.

Data compression may be used to speed up comparisons. For example lines of pixels which have the same value, either horizontally or vertically depending on the scanning direction, may be assigned a linear group value.

The pound sign in this example is not fluorescent and obscures the underlying fluorescence. The software may be programmed to ignore the area covered by this symbol.

As an alternative the bit map obtained in Figure 3 may be used for security validation (in that the presence of fluorescence or another optical attribute is detected) and the non-fluorescing areas would be used to form the templates which would be used for character recognition processing. In this instance the distorted "5" template would not be accepted as having an acceptable shape as the data templates for the numerical value shape would not match.

As a further aspect, the area which is to contain the handwritten value in full may also be printed with a normally invisible ultraviolet responsive visibly fluorescing dye.

In Figure 4, the cheque 1, of Figure 1, has invisible, fluorescent dye panels printed in all of the areas 18 - 23 (depicted diagrammatically by dotted lines) which will contain variable information. A secondary inspection may be made to establish whether alteration has occurred.

The areas may be inspected at two wavelengths and bit maps compared by analogy to Figures 2 and 3. Alternatively, inspection may occur only at the fluorescence emission wavelength. In this instance there can be a determination of the areas which are non-fluorescing. If the image patterns depart significantly from the expected linear profile which is generally formed with handwritten ink, for example it the area significantly thickens or if two colours of ink are spectrally detected then a reject condition will occur. The cheque will then be automatically rejected.

Thus, in Figure 5 is shown a section of the handwritten word portion of the cheque. This represents the visual appearance before alteration. In Figure 6, the visual appearance after alteration is given. In Figure 7, the appearance under background luminescing conditions is

shown. In this instance the density of ink in the altered area is seen to be greater than that in the other portions of the writing. This anomalous image density can be automatically detected by bit mapping and image analysis and a fault condition indicated.

Figure 8 illustrates an example in which only a single analysis is carried out. In this case the cheque 1 is fed by conveyor 51 to a station 61 which illuminates the cheque under ultraviolet light from a source 62 via fibre optic cables 63. Fluorescent light emitted from the cheque is detected by a linear CCD array 64 and corresponding signals are fed to a microprocessor 65 which generates a bit map. The bit map is compared with a set of previously stored bit maps in a memory 66 to see if the area of the bit map defines a valid character or characters. Alternatively, the microprocessor can perform a recognition analysis on the bit map to generate a signal defining the value of the characters written in the amount box.

CLAIMS

1. A method of inspecting a security document having an area which presents a characteristic appearance when illuminated under non-visible radiation and which, in use, carries one or more visible graphical characters, the method comprising illuminating the area under the non-visible radiation to derive data defining the appearance of the area; comparing the data with reference data; and indicating the result of the comparison.

2. A method according to claim 1, for verifying a security document, wherein the reference data defines one or more sets of data defining acceptable appearances of the area, the security document being verified as acceptable if the data defining the area under test substantially corresponds with one of the sets of reference data.

3. A method according to claim 1 or claim 2, wherein the graphical characters are numeric characters, the comparison step comprising determining the values defined by the graphical characters, and comparing the values with reference values.

4. A method according to claim 1, wherein the reference data is obtained by illuminating the area under radiation at a different, preferably visible, wavelength, and deriving data defining the appearance of the area under that radiation.

5. A method according to claim 4 for verifying a security document, the method comprising comparing the two sets of data and verifying the security document as genuine if the two sets are substantially the same.

6. A method according to any of the preceding claims, wherein the data comprises a bit map of the area under the respective radiation.

7. A method according to any of claims 1 to 5, wherein the data defines the meaning of the graphical characters.

8. A method according to any of the preceding claims, wherein the security document fluoresces or phosphoresces in the area.

9. A method according to claim 8, wherein the security document carries a fluorescent or phosphorescent ink in the area.

10. A method according to any of the preceding claims, wherein the security document includes an additional area which presents a characteristic appearance when illuminated under non-visible radiation.

11. A method according to claim 10, wherein the characteristic appearance comprises fluorescence or phosphorescence.

12. A method according to any of the preceding claims, wherein the area is designed to receive numeric data.

13. A method according to claim 12, wherein the security document comprises a cheque and the area is an amount box.

14. A method according to claim 13, in which fluorescent or phosphorescent ink covering the amount box is erasable under mechanical action.

15. Apparatus for inspecting a security document having an area which presents a characteristic appearance when illuminated under non-visible radiation and which, in use, carries one or more visible graphical characters, the apparatus comprising means for illuminating the area under the non-visible radiation; detection means for deriving data defining the appearance of the area; and processing means for comparing the data with reference data, and for indicating the result of the comparison.

16. Apparatus according to claim 15, wherein the detection means comprises a linear detector array.

17. A security document having an area which presents a characteristic appearance when illuminated under non-visible radiation and which, in use, carries one or more visible graphical characters and for use in a method according to any of claims 1 to 14 or with apparatus according to claim 15 or claim 16.

Fig. 1.

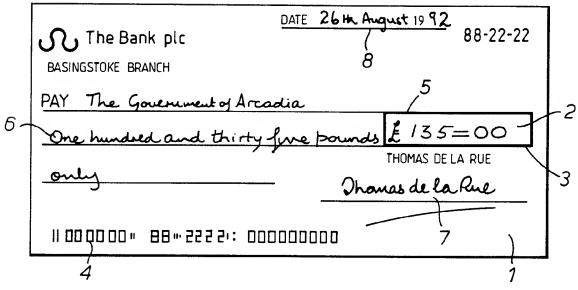


Fig. 2.

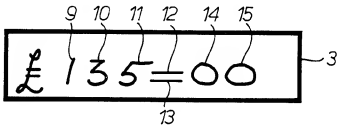


Fig. 3.

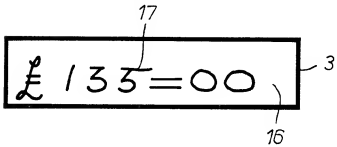


Fig. 4.

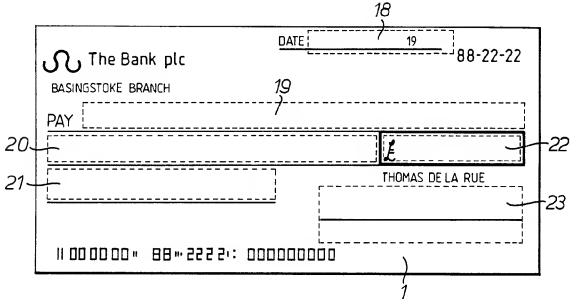


Fig. 8.

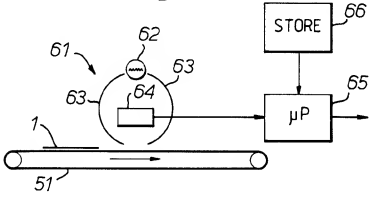


Fig. 9.

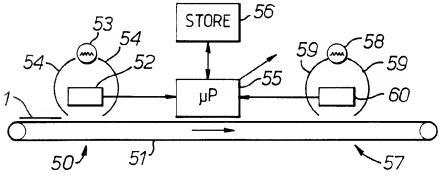


Fig.5.

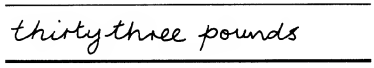


Fig.6.

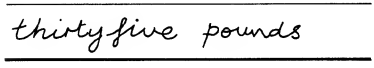
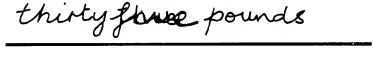


Fig.7.



INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 93/01077

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 G07D7/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	G07D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	EP,A,0 083 062 (TOKYO) 6 July 1983 see abstract	1-3,15, 17
Y	see page 9, line 6 - line 29 see claims 10,14	6,8,9,10

X	EP,A,0 088 169 (COMPAGNIE INDUSTRIELLE) 14 September 1983 see page 1, line 1 - line 5	1-3,15, 17
A	see page 2, line 31 - page 3, line 38 see page 4, line 35 - page 5, line 19 see page 6, line 25 - page 7, line 2 see claims 1,4-6,8	6

Y	EP,A,0 078 708 (DE LA RUE SYSTEMS LTD) 11 May 1983	6
A	see abstract	1-3

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° Special categories of cited documents :[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
29 JULY 1993	23. 08. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	TACCOEN J-F.P.L.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

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A	see abstract	11

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A	see abstract	1

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 9301077
SA 74391

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 29/07/93

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